APPENDIX I

APPENDIX I

SYSTEM IMPACTS/FACILITIES STUDY

System Impact / Facilities Study

Generation Interconnection

Midway Power, LLC

Tesla Generation Project

Preliminary

Pacific Gas and Electric Company™

August 3, 2001

Executive Summary

Midway Power, LLC (Applicant) is evaluating the feasibility of a 1156 MW[1] generating facility located approximately one mile northwest of the PG&E's Tesla Substation. The proposed generation project is called the Tesla Power Plant (TPP). The Applicant has requested that PG&E conduct a System Impact / Facilities Study (SI/FS) for this project. The planned on-line operation date of the proposed project is February 2004.

The SI/FS determined:

1. The facilities necessary to interconnect Applicant's generators to the grid,
2. The transmission system impacts caused solely by the addition of the TPP,
3. The system reinforcement necessary to mitigate the adverse impact of the TPP under various systems conditions, if any.

To determine the system impacts caused by the TPP, studies were performed using the 2004 Summer Full Loop Area Base Cases and Spring Peak Full Loop Base Cases. The studies performed included:

③ Steady State Power Flow.

③ Dynamic Stability Analysis.

③ System Protection.

The results of these studies were used in the transmission line and substation evaluations. The unit cost estimate is provided for the interconnection of the TPP.

PG&E's evaluation has concluded that the addition of the TPP will cause the following transmission line overloads:

2004 Summer Peak Full Loop Area Base Case

2 – Category B (Involving the same facility)

5 – Category C (Involving 5 different facilities)

2004 Spring Peak Full Loop Base Case

3 – Category B (Involving 2 different facilities)

7 – Category C (Involving 5 different facilities)

[1] This is the nominal rating of the generating facility as stated in Midway Power, LLC's Application for Certification filed with the California Energy Commission.

Mitigation alternatives and their associated estimate costs are provided for the Category B overloads only (there is no normal overload per power flow study).

Dynamic stability analysis concluded that the addition of the TPP would not affect the transmission grid stability.

The facilities costs for interconnecting the TPP to PG&E's grid are estimated to be $15,104,480[2].

The estimated cost of solutions to mitigate the Category B overloads range from $268,000 to $4,690,000[2].

[2] These costs are not final and will need to be reconciled with actual costs upon the signing of the interconnection agreements

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Appendices

1. Project Information

Midway Power, LLC (Applicant), a limited liability company formed by Florida Power and Light Energy (FPLE), has requested Pacific Gas and Electric Company (PG&E) to conduct a System Impact/Facilities Study (SI/FS) for the Tesla Power Plant (TPP). This project is located approximately one mile northwest of PG&E's Tesla Substation in Alameda County, California. Figure 1 shows the general vicinity of the TPP as well as the transmission facilities in the area.

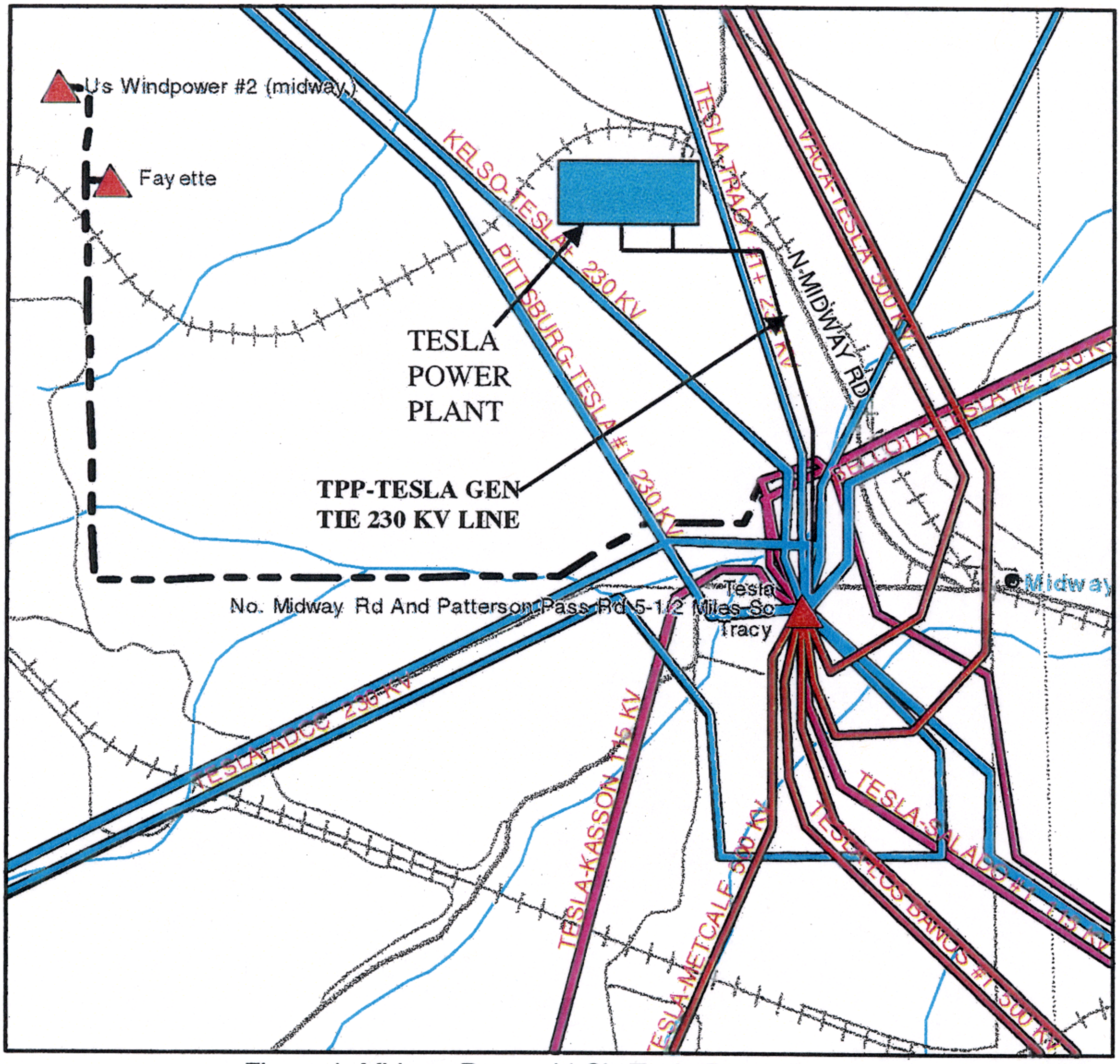

Figure 1: Midway Power, LLC's Tesla Power Plant

This SI/FS was conducted according to the terms and assumption set forth in PG&E's Study Plan document dated May 18, 2001, included in Appendix A. PG&E has combined the original request for Facility Study of Tesla I and System Impact Study of Tesla II. PG&E has collected from Midway Power, LLC a one-time fee of $135,000 ($60,000 and $75,000 as submitted originally) for performing this study.

PG&E had previously conducted a System Impact Study (SIS) for the TPP, and the final report was issued on February 27, 2001. The SIS was based on operational date of December 31, 2004, and the maximum net output was 844 MW (with three gas combustion turbine generators and one steam turbine generator).

In April 2001, the Applicant separated TPP into Tesla I and Tesla II. Tesla I would consist of four combustion turbine generators (CTGs) operating in simple cycle mode with a combined net maximum capacity of 692 MW. Tesla II would consist of two steam turbine generators (STGs) operated in combined cycle mode with the four CTGs of Tesla I. The addition of STGs should result in an increase of 464 MW output. Tesla I was planned to be on-line June 1, 2002, and Tesla II was planned to be on-line June 1, 2004. On May 10, 2001, due to time requirements for the permitting process, equipment availability, and other issues, the Applicant revised the schedule for the TPP such that the projects previously referred to as Tesla I and II will be operational at the same time-by February 1, 2004. This SI/FS is based on this on-line date.

The TPP will have a maximum rated generator output of 1183 MW at 0.85 power factor (generator nameplate rating) with a plant load of 27 MW. The expected maximum net output is 1156 MW. The proposed TPP will consist of:

③ Four-gas-fired combustion turbine/generators (CTG) rated at 221.4 MVA each.

③ Two-steam turbine/generator (STG) rated at 305 MVA each.

Each generator unit will have a dedicated 18/235 kV step-up transformer connected to a new 230 kV switchyard, located adjacent to the TPP site, that will transmit power produced by the TPP to PG&E's Tesla Substation.

The Applicant will build and own a new switchyard adjacent to the plant with two 230 kV collector buses. Each bus will be serviced two CTGs and one STG. The generator ties will be two single circuit 230 kV overhead transmission lines connecting the buses at the Applicant's switchyard to the 230 kV Bus E at the Tesla Substation. This route is approximately 1.0 mile long. The TPP and the transmission system will be configured as shown in Figure 2 below.

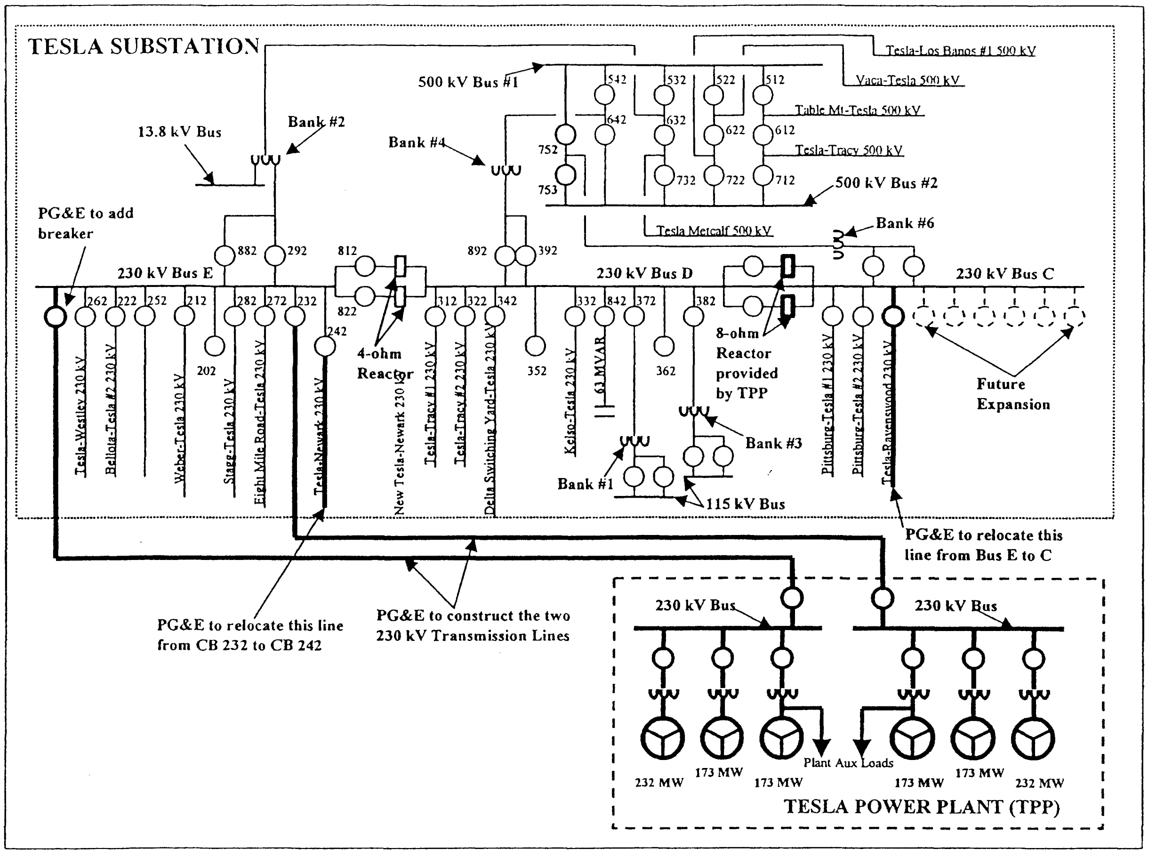

Figure 2: Single Line Diagram – Tesla Power Plant

2. Study Summary

2.1 Steady State Power Flow Study

Steady state power flow studies were conducted using the 2004 Summer Peak Full Loop Area and Spring Peak Full Loop base cases. The following is a summary of the results. Complete results are given in Section 6.

2.1.1 Normal Overloads (NERC Category A – No Contingencies)

During the summer and spring peak cases, no normal overload occurred as a result of the addition of the TPP.

2.1.2 Emergency Overloads (CAISO Category B)

During the 2004 Summer Peak Full Loop Area base case, the same facility is overloaded above its emergency ratings due to two Category B contingencies as a result of the addition of the TPP. During the 2004 Spring Peak Full Loop base case, there are two facilities with Category B overloads.

2.1.3 Emergency Overloads (CAISO Category C)

During the 2004 Summer Peak Full Loop Area base case, five facilities are overloaded above 100% of their emergency ratings under selected Category C contingencies as a result of the addition of the TPP. During the 2004 Spring Peak Full Loop base case, there are five facilities with seven Category C overloads.

2.2 Dynamic Stability Study

Dynamic stability studies were conducted to determine whether the TPP would create instability following certain outages. Section 7 outlines the outage scenarios assumed for this analysis and provides a complete analysis of the results. Dynamic Stability Study results indicated that the TPP would have no adverse impact on the stable operation of the transmission system following the selected disturbances.

2.3 System Protection Study

Short circuit studies were conducted to determine whether the TPP would result in overstressing of the existing substation facilities. Section 8 describes the results of the system protection study in detail.

2.4 Substation Evaluation

System Protection Study identified some over-stressed circuit breakers at the 230 kV Bus D and E resulting from the addition of the TPP. Since PG&E's Tesla Bank # 6 Project also over-stressed these same breakers, Bank # 6 Project will replace these over-stressed breakers. The estimated completion date for this breaker replacement is June 2002. In order to mitigate the additional fault current on the 230 kV buses caused by the TPP, a 8-ohm reactor is added between 230 kV Bus C and Bus D.

The TPP will connect to the 230 kV Bus E at the Tesla Substation. One circuit will be terminated at the end of this bus where the spare bay exists. The other circuit will be terminated at CB 232. The existing the Tesla-Newark # 1 230 kV line will move to CB 242 from CB 232, and the Tesla-Ravenswood 230 kV line currently connected to CB 242 will relocate to the new 230 kV Bus C at the Tesla Substation. See Section 10 for details.

2.5 Transmission Line Evaluation

The Transmission Line Evaluation was conducted in conjunction with the Steady State Power Flow study. The TPP causes transmission line overloads during some B and C contingencies. These facilities are identified in Section 6.

PG&E will design and construct the generator ties from the TPP to the Tesla Substation. See Section 9 for details.

3. Project Cost Estimate Summary

The following table provides a summary of the facilities cost estimates[3] for interconnecting the TPP with PG&E's transmission system. Appendix G includes the scope of the required work. Please note that these costs are not final and will need to be reconciled with actual costs upon the Applicant's signing of the interconnection agreements.

3.1 Interconnection Cost Summary

Substation Work		
Station Equipment	*$ 7,100,000*	
Property Improvement	*$ 25,000*	
Testing	*$ 85,000*	
O&M During Construction	*$ 30,000*	
Civil Foundation	*$ 250,000*	
Engineering and Project Management	*$ 210,000*	
Substation Subtotal		$ 7,700,000
Information System Technical Service		
Communication/ISTS Equipment & Installation	*$422.000*	
ISTS Subtotal		$422,000
Land Work		
Land and Land Rights Evaluation	*$ 50,000*	
Land Work Subtotal		$ 50,000
Transmission Line Work		
Engineering, Maintenance and Operations	*$ 100,000*	
Transmission Tower Work	*$2,500,000*	
Overhead Conductor & Devices	*$500,000*	
Transmission Line Work Subtotal		$ 3,100,000
Subtotal Interconnection Cost		**$11,272,000**
ITCC Tax[4] @ 34 %		**$3,832,480**
Total		***$15,104,480***

[3] The PG&E interconnection engineering cost estimates are developed with a theoretical confidence level of 25 percent. Billing will be based on an actual cost basis.

[4] Both the Federal Government and the State of California consider funds and property received by the Utility in order to provide utility service as income. From IRS Notice 87-82, Section III on Fair Market Value of Income Tax Component of Contribution (ITCC), "[a] Utility shall include as income the amount of any cash received as a CIAC (Contribution in aid of construction) and the fair marketing value of all property received as a CIAC." ITCC charge is collected from a customer to keep PG&E's ratepayers from being negatively impacted by the customer's service. The ITCC tax charge represents the current tax rates that PG&E must pay on its revenue to the Federal Government and the State of California. PG&E's current tax rate for electric revenue is 34%.

3.1 System Impact Mitigation Cost Summary

The costs associated with mitigating the overloads described in Section 6 are summarized in this section.

The costs were developed using PG&E unit costs, which are average costs for installing an asset such as a circuit breaker or re-conductor one mile of transmission line. Unit costs do not account for special circumstances and have no intended degree of accuracy. Unit costs are usually lower than actual costs of a project, which may be greater than unit costs by more than 50%.

3.1.1 Contra Costa-Las Positas 230 kV

	Alternative Solution	Cost before Tax	ITCC Tax	Total Cost
1	Re-rate the line (already re-rated by PG&E)	N/A	N/A	**N/A**
2	Special Protection Scheme to drop generation	$200,000	$68,000	**$268,000**

3.1.2 Delta Switching Yard-Tesla 230 kV

	Alternative Solution	Cost before Tax	ITCC Tax	Total Cost
1	Re-conductor the line approximately 7 miles	$3,500,000	$1,190,000	**$4,690,000**
2	Special Protection Scheme to drop generation	$200,000	$68,000	**$268,000**

3.1.3 Contra Costa-Delta Switching Yard 230 kV

	Alternative Solution	Cost before Tax	ITCC Tax	Total Cost
1	Re-rate the line	$200,000	$68,000	**$268,000**
2	Special Protection Scheme to drop generation	$200,000	$68,000	**$268,000**

4. Interconnection Study Assumptions

PG&E conducted the SIS/FS under the following assumptions:

1) The maximum (net) delivery from the proposed project to the PG&E transmission grid will be 1156 MW modeled at 0.85 power factor. The project will be on line at this capacity by February 2004.

2) The Applicant will design, build, own, and maintain the TPP and the 230 kV switchyard.

3) PG&E will design, construct, own and maintain approximately one mile of 230 kV generation overhead tie lines using single conductor of 954 SSAC per phase from the TPP to the Tesla Substation.

4) The study will take into account the planned generating facilities in Stockton Area whose schedules are concurrent with the TPP's schedule. These facilities are described in the section discussing the power flow base cases.

5) The study will take into account all the approved PG&E transmission reliability projects that will be operational by February 2004.

6) The new current limiting reactor installed between 230 kV Bus D and C at the Tesla Substation is 8-ohm based on the maximum output of 1156 MW at 0.85 lagging power factor, and the TPP is connecting to 230 kV Bus E.

5. Base Case Assumptions Used for Power Flow Study

Power flow analyses were performed using PG&E's 2004 Summer Peak Full Loop Area and Spring Peak Full Loop Base Cases (in General Electric Power Flow format). These base cases were developed from PG&E's 2001 base case series.

1. **2004 Summer Peak Full Loop Area Base Case:**

   Power flow analysis was performed using PG&E's 2004 Summer Peak Full Loop Area Base Case (in General Electric Power Flow format). This base case has a 1-in-10 year heat wave load forecast for the Sacramento, Sierra, Stockton, and Stanislaus areas. This base case was used to evaluate the impact of the TPP on PG&E's 60-500 kV system.

2. **2004 Spring Peak Full Loop Base Case:**

   Power flow analysis was also be performed using the 2004 Spring Peak Full Loop Base Case in order to evaluate the potential congestion on transmission facilities with lower load and high generation level during a typical Spring season. Typical Spring season load (50-65% of summer peak) was applied in this Spring Peak Base Case. Hydro generations were modeled in a very high level as typical in the spring season. This base case was used to evaluate the impact of the TPP on PG&E's 60-500 kV system.

5.1 Base Case PG&E Approved Reliability Project Assumptions

- Install a third 500/230 kV transformer at Tesla Substation
- Install a second 500/230 kV transformer at Tracy Substation

- Install a third 500/230 kV transformer at Metcalf Substation
- A new Tesla-Newark 230 kV line
- Newark-San Mateo 230 kV line loop into Ravenswood Substation
- Static Capacitors (350 MW) at Metcalf 500 kV
- Static Capacitors (100 MW) at Martin 115 kV
- Newark Substation Bank #7, 9, and 11 TCAP

5.2 Base Case Generation Assumptions

1) Calpine/Bechtel - 880 MW Delta Energy Center (DEC), interconnecting with the 230 kV bus at the Pittsburg Power Plant switchyard.

2) Calpine/Bechtel - 600 MW Metcalf Energy Center (MEC), interconnecting with the Metcalf - Monta Vista #4 230 kV line, through the MEC switchyard.

3) PG&E NEG - La Paloma generation facility interconnecting at Midway 230 kV bus section D; La Paloma generation facility will be will be modeled at 1110 MW in summer and 1160 MW in spring and winter.

4) Calpine - 500 MW Los Medanos Energy Center (LMEC), interconnecting with the 115 kV bus at the Pittsburg Power Plant switchyard.

5) Texaco - 338 MW Sunrise Generation Facility interconnecting at La Paloma Switching Station.

6) Three Mountain Power Company - 530 MW project interconnecting to PG&E's Pit 1 – Pit 3 and Pit 1 – Cottonwood 230 kV lines.

7) GWF - 99 MW Hanford, interconnecting to Kingxburg - Henrietta 115 kV line in Fresno area.

8) Duke Energy North America Corporation (DENA) - 1080 MW Moss Landing project (MLPP), interconnecting with the existing 230 kV bus at the Moss Landing Power Plant.

9) Southern Energy Company of California - 530 MW Contra Costa Power Plant Capacity Increase Project, interconnecting to Contra Costa PP 230 kV bus.

10) The Midway-Sunset generation facility will be 490 MW in summer, 540 MW in spring, and 540 MW winter. Midway-Sunset generation facility will be interconnected at Midway 230 kV bus section E.

11) Sempra - 500 MW Elk Hills Power Project, interconnecting at Midway 230 kV bus.

12) FPLE - 150 MW High Wind, tapping off the Vaca -Contra Costa #2 230 kV line.

13) United Golden Gate PP - 595 MW generating facilities, interconnecting with the San Mateo - Martin #5 and #6 115 kV lines.

14) Morro Bay Modernization Project replacing the existing Morro Bay Power Plant with 1,200 MW of generation.

15) Panda - 150 MW West 1-3, interconnecting with Vaca Dixon - Contra Costa #1 230 kV line

16) Calpine Corporation - 500 MW Sutter Facility, interconnecting with WAPA's Elverta - Olinda and Elverta - Keswick 230 kV.

17) FPLE - 560 MW Elverta Project, interconnecting with WAPA system.

18) Calpine – 1,070 MW East Altamont Generating Project interconnecting at loop the Tracy - Westley 230 kV circuit near Tracy Substation.

5.3 Study Criteria Summary

The CAISO Controlled Grid Reliability Criteria, which incorporate the Western Systems Coordinating Council (WSCC) and the North American Electric Reliability Council (NERC) planning criteria, were used to evaluate the impact of the project on the PG&E transmission system. Table 1 provides a summary of the CAISO Controlled Grid Reliability Criteria.

	Loading [5]	Transient Voltage Dip & Frequency
All Lines in Service Category "A"	≤ Normal Ratings	—
ISO Category "B" Contingency[6]	≤ Emergency Ratings	≤ 25% at load buses, ≤ 30% at non-load buses, > 20% voltage, ≤ 20 cycles at load buses, > 59.6 Hz < 59.6 Hz for 6 cycles
ISO Category "C" Contingency[7]	≤ Emergency Ratings	≤ 30% at any bus > 20% voltage, ≤ 40 cycles, > 59 Hz < 59 Hz for 6 cycles

Table 1: CAISO Controlled Grid Reliability Criteria

[5] The ratings are listed in the CAISO Transmission Register.
[6] CAISO Category "B" contingency refers to all single component outages such as the loss of a transmission line (L-1), a generator (G-1), a transformer (T-1). Also, it refers to the loss of the combination of a single transmission line and a single generator unit.
[7] CAISO Category "C" contingency refers to outages resulted from the loss of two or more (multiple) components except the loss of the combination of a single transmission line and a single generator unit.

5.4 Steady State Study Criteria – Normal Overloads

Normal overloads are those that exceed 100 percent of normal ratings. The CAISO Controlled Grid Reliability Criteria requires the loading of all transmission system facilities be within their normal summer ratings.

5.5 Steady State Study Criteria – Emergency Overloads

Emergency overloads are those that exceed 100 percent of emergency ratings. The emergency overloads refer to overloads that occur during single element contingencies (CAISO Category "B") and multiple element contingencies (CAISO Category "C").

5.6 Dynamic Stability Study Criteria

According to the WSCC Disturbance-Performance Table of Allowable Effects on Other Systems[8], after a Category "B" disturbance, the transmission system performance should meet the following criteria:

- Transient voltage dip should not be below 25 percent at load buses or 30 percent at non-load buses at any time.
- The duration of the transient voltage dip greater than 20 percent should not exceed 20 cycles at load buses.
- The minimum transient frequency should not fall below 59.6 Hz for more than 6 cycles at load buses.

After a Category "C" disturbance, the transmission system performance should meet the following criteria:

- Transient voltage dip should not be below 30 percent at any bus at any time.
- The duration of a transient voltage dip greater than 20 percent should not exceed 40 cycles at load buses.
- The minimum transient frequency should not fall below 59.0 Hz for more than 6 cycles at load buses.

6. Steady State Power Flow Study

The 2004 Summer Peak Full Loop Area and Spring Peak Full Loop Base Cases were used to simulate the impact of the new facility during normal operating conditions, as well as, single and multiple (ISO Categories "B" and "C") outages. The study covered the transmission facilities within PG&E's Stockton planning area.

[8] Cited from Draft Western System Coordinating Council (WSCC) Planning Standards published in December 2, 1999.

6.1 Contingencies

The CAISO Category "B" and "C" contingencies used in this analysis are provided in Appendix B. The single (ISO Category "B") and selected multiple (ISO Category "C") contingencies include the following outages:

6.1.1 ISO Category "B"

- ③ Single generator outages
- ③ Single (60-500 kV) transmission circuit outages
- ③ Single transformer outages
- ③ Selected overlapping single generator and transmission circuit outages

6.1.2 ISO Category "C"

- ③ Selected bus outages (115 kV – 230 kV).
- ③ Selected breaker (excluding bus tie and section) failures (115 kV - 500 kV)
- ③ Selected combinations of two successive Category "B" outages (115 kV – 500 kV).
- ③ Selected double circuit tower line outage (115 kV – 500 kV).

The base cases, described in Section 5, were used to simulate CAISO single and multiple contingencies for transmission facilities within PG&E's East Bay and Stockton Divisions. The results of the analyses are shown in a summarized form in Appendix D. It includes power flow diagrams for normal and emergency operating conditions of summer and spring with and without the TPP.

The overall study results indicated that interconnection of the TPP would create various small emergency overloads.

6.2 Results

Appendix D includes selected power flow plots for summer peak and spring operating conditions. The base cases described in Section 5 was used to simulate CAISO single and multiple contingencies for transmission facilities within PG&E's Stockton Divisions.

6.2.1 2004 Summer Peak Full Loop Area Base Case Power Flow Results

Power flow studies were conducted with and without the TPP connected to the PG&E's grid under 2004 Summer Peak Full Loop Area Base Case operating conditions. The results showed no normal overload due to the addition of the TPP (Category A).

For CAISO Category B outage conditions, one facility was overloaded above its emergency ratings during two outages. Table 2 provides a summary of the overload.

Contingency	Over Loaded Component	Rating (Amps)	Pre- Project Loading (Amps |%Rating)		Post-Project Loading (Amps |%Rating)		% Change from Pre-Project Loading
Tesla-Newark # 1 230 kV line	Contra Costa-Las Positas 230 kV line	1024.2	997.3	97.4	1065.1	104.0	6.6
Contra Costa-Newark # 2 230 kV line	Contra Costa-Las Positas 230 kV line	1024.2	1004.7	98.1	1029.7	100.5	2.4

Table 2: The TPP - 2004 Summer Peak Full Loop Area Base Case – Category B overloads

For CAISO Category C outages, five transmission facilities were overloaded above their emergency ratings. Table 3 shows the results for the overloads identified for these system components.

Contingency	Over Loaded Component	Rating (Amps)	Pre- Project Loading (Amps |%Rating)		Post-Project Loading (Amps |%Rating)		% Change from Pre-Project Loading
Tesla-Newark # 1 230 kV line	Contra Costa-Las Positas 230 kV line	1024.2	1007.3	98.4	1085.2	106.0	7.6
Contra-Las Positas & Pittsburg-Moraga 230 kV lines	Pittsburg-Moraga # 1 230 kV (Rossmoor Tap # 1 to Moraga)	953.9	944.3	99.0	1007.2	105.6	6.6
Tesla-ADCC & Tesla-Newark # 1 230 kV lines	Trimble-San Jose B 115 kV line	923.8	912.7	98.8	947.6	102.6	3.8
Metcalf-newark #1 & 2 230 kV lines	Newark-Scott # 1 115 kV line	948.9	939.4	99.0	964.4	101.6	2.6
TPP-Tesla E 230 kV lines	Morro Bay-Templeton 230 kV line	975.0	N/A	N/A	981.2	101.0	N/A

Table 3: The TPP - 2004 Summer Peak Full Loop Area Base Case – Category C overloads

6.2.2 2004 Spring Peak Full Loop Base Case Power Flow Results

Power flow studies were showed no normal overloaded due to the addition of the TPP.

For CAISO Category B outage conditions three facilities were overloaded above their emergency ratings. Table 4 provides a summary of these overloads.

Contingency	Over Loaded Component	Rating (Amps)	Pre- Project Loading (Amps |%Rating)		Post-Project Loading (Amps |%Rating)		% Change from Pre-Project Loading
500/230 kV Transformer Bank at Vaca Dixon Sub	Delta Switching Yard-Tesla 230 kV line	975.0	967.6	99.2	1181.1	121.1	21.9
500/230 kV Transformer Bank at Vaca Dixon Sub	Contra Costa-Delta Switching Yard 230 kV line (Contra Costa to Wind Farm)	974.0	854.7	87.7	1068.1	109.6	21.9
500/230 kV Transformer Bank at Vaca Dixon Sub	Contra Costa-Delta Switching Yard 230 kV line (Wind Farm to Delta Switching yard)	974.0	855.2	87.7	1068.7	109.6	21.9

Table 4: The TPP - 2004 Spring Peak Full Loop Base Case – Category B overloads

For CAISO Category C outages, five transmission facilities are overloaded above their emergency ratings during seven contingencies. Table 5 shows the results for the overloads identified for these system components.

Contingency	Over Loaded Component	Rating (Amps)	Pre- Project Loading (Amps |%Rating)		Post-Project Loading (Amps |%Rating)		% Change from Pre-Project Loading
Tesla-ADCC-Newark 230 kV lines	Delta Switching Yard-Tesla 230 kV line	975.0	898.5	92.2	1144.5	117.4	25.2
Tesla-ADCC-Newark 230 kV lines	Contra Costa-Delta Switching Yard 230 kV line (Contra Costa to Wind Farm)	974.0	785.4	80.6	1030.9	105.7	25.1
Tesla-ADCC-Newark 230 kV lines	Contra Costa-Delta Switching Yard 230 kV line (Wind Farm to Delta Switching yard)	974.0	785.8	80.6	1031.4	105.8	25.2
Tesla-Ravenswood 230 kV line	Tesla-Ravenwood 230 kV line (Tesla to Newark)	2880.3	2447.3	85.0	2965.6	103.0	18.0
Tesla-Ravenswood 230 kV line	Tesla-Ravenswood 230 kV line (Newark to Ravenwood)	2110.0	2087.7	98.9	2168.7	102.8	3.9
Contra Costa-Las Pasitas & Contra Costa-Moraga 230 kV lines	Pittsburg-Moraga # 1 230 kV (Rossmoor Tap # 1 to Moraga)	953.9	869.4	91.1	1006.3	105.5	14.4
Tesla-ADCC-Newark 230 kV lines	Contra Costa-Las Pacitas 230 kV line	1024.2	939.1	91.7	1036.0	101.2	9.5

Table 5: The TPP - 2004 Spring Peak Full Loop Base Case – Category C overloads

7. Dynamic Stability Study

Dynamic stability studies were conducted using the base cases described in Section 5 and to determine whether the transmission system would attain operating equilibrium following selected outages.

7.1 Results

The results indicated that the transmission system performed within the CAISO reliability guidelines following the disturbances outlined below. It was determined that the TPP would have no adverse impact on the stable operation of the transmission system.

The results of the study are provided in the form of plots in Appendix F. A switch-deck script describing the switching sequence precedes each group of plots.

7.2 Dynamic Stability Study Scenarios

The following outage scenarios were simulated for a study period of up to 20 seconds:

7.2.1 NERC/CAISO Category "B" Contingencies:

1) Full load rejection of the TPP power plant.

2) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus, followed by loss of the Tesla-Ravenswood 230 kV line.

3) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus, followed by loss of the Tesla-Newark 230 kV line.

4) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus followed by loss of the Tesla-Tracy #1 230 kV line.

5) A three-phase fault with a normal 6-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla 500/230 kV Bank #2.

6) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Table Mountain-Tesla 500 kV line.

7) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Vaca-Tesla 500 kV line.

8) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Tracy 500 kV line.

9) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Los Banos 500 kV line.

10) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Metcalf 500 kV line.

11) A three-phase fault with a normal 6-cycle clearing time at the Tesla 115 kV bus, followed by loss of the Tesla 230/115 kV Bank #3.

7.2.2 NERC/CAISO Category "C" Contingencies:

1) A three-phase fault with a normal 6-cycle clearing time on the Tesla 230 kV Bus #2, Section D.

2) A three-phase fault with a normal 6-cycle clearing time on the Tesla 230 kV Bus #2, Section E.

3) A three-phase fault with a normal 6-cycle clearing time on the Tesla 115 Bus #2.

4) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus followed by a simultaneous loss of both Tesla-Tracy 230 kV lines.

5) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus followed by a simultaneous loss of the Table Mountain-Tesla and Vaca-Tesla 500 kV lines.

6) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus followed by a simultaneous loss of the Tesla-Tracy and Tesla-Los Banos 500 kV lines.

7) A single-line-to-ground fault at the Tesla 230 kV Bus #2, Section D, with a breaker failure condition.

8) A single-line-to-ground fault at the Tesla 230 kV Bus #2, Section E, with a breaker failure condition

7.3 Parameters Monitored to Evaluate System Stability Performance

7.3.1 Rotor Angle

The rotor angle plots shown in Appendix F provide a measure for determining how the proposed generation units would swing with respect to one another. The plots also provide a measure of how the units would swing with respect to other generation units in the area.

7.3.2 Bus Voltage

The bus voltage plots, in conjunction with the relative rotor angle plots, also shown in Appendix F, provide a means of detecting out-of-step conditions. The bus voltage plots are useful in assessing the magnitude and the duration of post disturbance voltage dips and peak-to-peak voltage oscillations. The bus voltage plots also give an indication of system damping and the level to which voltages are expected to recover in steady state conditions.

7.3.3 Bus Frequency

The bus frequency plots provide information on the magnitude and the duration of post fault frequency swings with the TPP in service. These plots indicate the extent of possible over-frequency or under-frequency, which can occur because of the imbalance between the generation and load within an area.

7.3.4 Other Parameters

③ Generator Terminal Power

③ Generator Terminal Voltage

③ Generator Rotor Speed

③ Generator Field Voltage

③ Bus Angle

③ Line Flow

③ Voltage Spread

③ Frequency Spread

8. System Protection Study

Short circuit studies were performed to determine the impact of adding the TPP to the transmission system. The fault duties were calculated before and after the project. The Applicant provided the input data used in this study.

8.1 System Protection Study Input Data

Combustion Turbine Generator

③	Synchronous reactance (X_d)	= 2.170 pu @ 239 MVA
③	Transient reactance (X'_d)	= 0.265 pu @ 239 MVA
③	Sub-transient reactance (X''_d)	= 0.200 pu @ 239 MVA
③	Negative Sequence reactance (X_{-})	= 0.155 pu @ 239 MVA (sat)
③	Zero Sequence reactance (X_0)	= 0.130 pu @ 239 MVA (sat)

Steam Turbine Generator

③	Synchronous reactance (X_d)	=1.825 pu @ 299 MVA

- ③ Transient reactance (X'_d) =0.313 pu @ 299 MVA
- ③ Sub-transient reactance (X''_d) =0.226 pu @ 299 MVA
- ③ Negative Sequence reactance (X_-) =0.164 pu @ 299 MVA (sat)
- ③ Zero Sequence reactance (X_0) =0.098 pu @ 299 MVA (sat)

Step-up Transformers

- ③ CTG 18/230 kV, Z = 8.4 % @ 129 MVA (two)
- ③ STG 18/230 kV, Z = 10.4 % @ 180 MVA

8.2 Results

Table 6 shows the maximum fault currents at the buses studied with and without the project. Bus connection in 1 through 6 is with switches between Bus C & D and existing 4-ohm reactor between Bus D & E. Bus connection in 7 through 12 is with a 4-ohm reactor between Bus C & D and existing 4-ohm reactor between Bus D & E. Bus connection in 13 through 18 is with 8-ohm reactor between Bus C & D and existing 4-ohm reactor between Bus D & E. All 230 kV breakers at the Tesla Substation are rated for 63 kA.

	Substation Bus		Case 1 Before TPP		Case 2 After TPP		INCREASE (Case 2 over Case 1)	
	Bus	kV	3PH	1LG	3PH	1LG	3PH	1LG
1	Bus C @ Tesla Sub	230	**68,862**	**66,789**	**72,730**	**72,092**	5.62%	7.94%
2	Bus D @ Tesla Sub	230	**69,419**	**67,289**	**73,402**	**72,739**	5.74%	8.91%
3	Bus E @ Tesla Sub	230	49,954	48,805	60,226	**63,434**	20.56%	30.0%
4	Bus A @ Tesla Sub	500	35,501	30,149	37,043	32,271	4.34%	7.04%
5	Bus F @ Tesla Sub	115	28,286	31,606	28,563	31,981	1.00%	1.19%
6	TPP-RB	230	N/A	N/A	55,818	58,302	N/A	N/A
7	Bus C @ Tesla Sub	230	46,556	45,883	47,780	47,649	2.63%	3.85%
8	Bus D @ Tesla Sub	230	60,466	58,554	**64,084**	**63,442**	5.98%	8.35%
9	Bus E @ Tesla Sub	230	48,950	47,890	59,223	62,506	21.0%	30.5%
10	Bus A @ Tesla Sub	500	35,487	30,123	37,030	32,228	4.35%	6.99%
11	Bus F @ Tesla Sub	115	27,657	30,959	27,987	31,378	1.19%	1.35%
12	TPP-RB	230	N/A	N/A	54,987	57,642	N/A	N/A
13	Bus C @ Tesla Sub	230	41,373	40,923	42,197	42,134	1.99%	2.96%
14	Bus D @ Tesla Sub	230	57,607	55,762	61,100	60,456	6.06%	8.42%
15	Bus E @ Tesla Sub	230	48.703	47,663	58,975	62,256	21.1%	30.6%
16	Bus A @ Tesla Sub	500	35,500	30,130	37,039	32,217	4.34%	6.93%
17	Bus F @ Tesla Sub	115	27,447	30,717	27,771	31,151	1.18%	1.41%
18	TPP-RB	230	N/A	N/A	54,781	57,448	N/A	N/A

Table 6: Short circuit study results for Substation Buses

The connection configuration with the 8-ohm reactor installed between 230 kV Bus D and C (as shown by items 13 through 18 in Table 6) will reduce the fault current on all 230 kV buses below the current breaker rating of 63 KA when the TPP is in operation.

9. Transmission Line Evaluation

As shown by the Power Flow Study, the addition of the TPP would overload some transmission lines during Category B and C contingencies.

Mitigation alternatives have been provided for the Category B contingency in Section 12. Unlike CAISO Category B outages, CAISO Category C outages (according to WSCC reliability criteria) may be mitigated by load shedding or generation dropping. Therefore, the Applicant is not required to mitigate overloads caused by CAISO Category C outages by installing or upgrading physical facilities. The Applicant is not required to mitigate these types of problems at this time. However, PG&E or CAISO or both may require new generators to take part in and be responsible for the costs of operating procedures or special protection schemes or both that will eventually be planned to mitigate these rare occurrences.

PG&E will design and construct the generator ties from the TPP to the Tesla Substation. These two single circuit 230 kV transmission overhead (on steel frame towers) lines will be single conductor 954 SSAC per phase and about one mile in length. These lines also will cross over some existing 230 and/or 115 transmission lines.

10. Substation Evaluation

The System Protection Study identified no overstressed breaker at any 230 kV bus if a 8-ohm reactor is installed between the 230 kV Bus C and D (Table 6).

The interconnection configuration identified that one of the generator tie line will be terminated at the east end space of the 230 Bus E. The other generator tie line will be terminated at CB 232 at the 230 kV Bus E. The existing circuit, the Tesla-Newark # 1 230 kV line, will be relocated to adjacent CB 242. The Tesla-Ravenswood 230 kV line, which is currently connected at CB 242 will be moved to the 230 kV Bus C. New breakers and associated protection and control devices are required for this connection. The substation work scope will include the modification on these buses (such as adding breakers, disconnect switches, sensors, etc.) as well as the substation control room panels (relays, control switches, indications, etc.).

The communication associated with the connection of the TPP is also required.

Bus rating verification is required to ensure the existing buses are adequately sized.

Appendix G provides a preliminary outline of the substation work that would be required to add the TPP to PG&E's transmission grid.

11. Environmental/Permitting

The California Public Utilities Commission (CPUC) has jurisdiction over the construction and operation of electric transmission facilities by PG&E. The CPUC's General Order 131-D provides for the construction of needed electric transmission lines or substations to interconnect electric generation plants. In cases where the utility owned electric transmission line or substation is part of a larger project that that has undergone environmental review by a local agency, General Order 131-D exempts PG&E from obtaining a Permit to Construct (PTC) from the CPUC. In order to be exempted from the PTC, the final California Environmental Quality Act (CEQA) document issued by the local agency must find no significant unavoidable environmental impacts caused by PG&E's facility. Obtaining a PTC can take as much as 18 months because the CPUC is the lead agency under CEQA and may require an environmental impact report (EIR).

The Applicant will be responsible for including all work required by PG&E for directly interconnecting the TPP to PG&E's transmission grid in the environmental review for the Applicant's application for a discretionary permit to build the TPP. If the lead agency finds that this work will not have any significant unavoidable environmental impacts, PG&E will not apply for any permits from the CPUC for this interconnection work unless ordered to do so by the CPUC. Rather, PG&E will follow the notice requirements set out in section III and XI.B of the CPUC's General Order (GO) 131-D, including mailing to agencies, posting, publication, and submittal of an informational advice letter to the CPUC. If the lead agency finds that this work will have any significant unavoidable environmental impacts, or if the project does not require another discretionary permit, then PG&E will comply with applicable GO 131-D permitting requirements.

Please see Section III, B.1. (f) in General Order 131-D. This document can be found in the CPUC's web page at:
http://www.cpuc.ca.gov/published/index_pages/general_orders_index.htm

12. Mitigation Alternatives

12.1 Mitigation Methodology

This section provides the alternatives available for mitigating the normal and Category B emergency overloads. Mitigation of the overloads can be achieved by the following methods:

③ **Re-conductor overloaded circuits.**

③ **Replace overloaded facilities.**

③ **Re-rate[9] selected overloaded circuits.**

[9] A request for a re-rate is subject to transmission line analysis and may not be feasible.

Re-rating of transmission facilities requires a study of the precise operating conditions of each facility. For instance, an examination of prevailing winds in a facility's area might allow an assumption that the average wind speed would be higher than the 2 feet-per-second that PG&E uses as a standard. Based upon such a determination, the rating of a transmission line can be raised. A request for a re-rate is subject to transmission line analysis and may not be feasible. Usually re-rating a transmission line is less expensive than re-conductor.

③ **Install a Special Protection Scheme (SPS) to mitigate emergency overloads by dropping generation.**

Special Protection Schemes (SPS) use automatic control to reduce generation during the contingencies that cause overloads. An SPS is usually similar in cost to re-rating and is usually less expensive than re-conductor. However, Midway Power, LLC would lose revenue from the reduced generation and generation would be off-line when it is most needed to support then system.

③ **Other Solutions**

There are solutions that may not be obvious or would involve combinations of the above mitigation solutions. Such a solution might be used to mitigate multiple overloads.

12.2 Overstressed Breaker Mitigation

The only mitigation available for the overstress circuit breakers revealed by the System Protection Study is replacement of all breakers. PG&E's current Bank # 6 Project would be responsible for the replacement of all overstressed breakers at 230 kV buses at the Tesla Substation.

12.3 Mitigation of Facilities Identified by Power Flow

Table 7 provides a summary of the mitigation of the worst overloads for each facility.

Contingency	Over Loaded Component	Rating (Amps)	Pre- Project Loading (Amps /%)	Post-Project Loading (Amps /%)	Total # of OL continge ncies	Limiting Component	Gen Drop/add to Mitigate New Overloads
Tesla-Newark # 1 230 kV line	Contra Costa-Las Positas 230 kV line	1024.2	999/97.5	1066.5/104.1	2	Over Head Conductor	204 MW
500/230 kV Transformer Bank at the Vaca Dixon Substation	Delta Switching Yard-Tesla 230 kV line	975.0	974.5/100	1198.4/122.9	1	Over Head Conductor	Add 335 MW
500/230 kV Transformer Bank at the Vaca Dixon Substation	Contra Costa-Delta Switching Yard 230 kV line	974.0	862/88.4	1085.8/111.4	1	Over Head Conductor	Add 335 MW
Tesla-Newark # 1 & 2 230 kV lines	Contra Costa-Las Positas 230 kV line	1024.2	1007.2/98.3	1087/106.1	2	Over Head Conductor	+
Contra-Las Positas & Pittsburg-Moraga 230 kV lines or Contra Costa-Las Pasitas & Contra Costa-Moraga 230 kV lines	Pittsburg-Moraga # 1 230 kV (Rossmoor Tap # 1 to Moraga)	953.9	871.2/91.3	1012.4/106.1	2	Over Head Conductor	+
Tesla-ADCC & Tesla-Newark # 1 230 kV lines	Trimble-San Jose B 115 kV line	923.8	913.1/98.8	948.1/102.6	1	Over Head Conductor	*
Metcalf-newark #1 & 2 230 kV lines	Newark-Scott # 1 115 kV line	948.9	885.5/93.3	964.6/101.7	1	Over Head Conductor	+
TPP-Tesla E 230 kV lines	Morro Bay-Templeton 230 kV line		N/A	981.2/101.0	1	Over Head Conductor	**
Tesla-Newark # 1 & 2 230 kV lines	Delta Switching Yard-Tesla 230 kV line	975.0	910.9/93.4	1171.5/120.2	1	Over Head Conductor	+
Tesla-Newark # 1 & 2 230 kV lines	Contra Costa-Delta Switching Yard 230 kV line	974.0	798.2/81.9	1958.5/108.6	2	Over Head Conductor	+
Tesla-Ravenswood 230 kV line	Tesla-Ravenwood 230 kV line (Tesla to Newark)	2880.3	2428.1/84.3	2925.5/101.6	1	Over Head Conductor	+
Tesla-Ravenswood 230 kV line	Tesla-Ravenswood 230 kV line (Newark to Ravenwood)	2110.0	2085.7/98.8	2164.2/102.6	1	Over Head Conductor	+

Table 7: The Tesla Power Plant – Load Flow Analysis, Worst Overloads

* Mitigation of San Jose "B" - FMC JCT 115 kV Line

The San Jose "B" - FMC JCT 115 kV Line consists of a 20 feet, 715 kcmil AL conductor with 2 feet/second (wind speed) rating from the San Jose "B" sect. "E" bus to the first tower span. This short line section is already overloaded under various Category "B" outage conditions prior to this generation project. This generation project will further increase the overload by 23% to 24%.

PG&E is currently preparing a project justification to replace this short line section with 477 SSAC or equivalent. It is expected that this PG&E transmission project will be completed by early 2002. In order to mitigate the increased overload caused by this project, a large conductor size, such as 954 SSAC or equivalent, may be needed.

** Mitigation of Morro Bay-Templeton 230 kV Line

This line overload results from loss of the TPP 230 kV bus fault contingency. The swing bus is Morro Bay, so it follows that the loss of the TPP 1156 MW output would cause the Morro Bay units to increases output well beyond its capability.

\+ Mitigation CAISO Category C overloads – see Section 9 for detail.

12.3.1 B Contingencies: Tesla-Newark # 1 230 kV line Overloaded Component: Contra Costa-Las Positas 230 kV line

Mitigation Option: The Contra Costa-Las Positas 230 kV line has been re-rated by PG&E. The only mitigation is to implement Special Protection Scheme (SPS) to reduce 204 MW or 54 MW output at the Contra Costa Power Plant to mitigating the two Category B Contingencies. These are the estimated required reduction in outputs with all transmission facilities in service. [10]

12.3.2 B Contingency: 500/230 kV Transformer Bank at Vaca Dixon Sub Overloaded Component: Delta Switching Yard-Tesla 230 kV line

Mitigation Option 1: Re-conductor approximately 7 miles 230 kV transmission line with 1272 ACSR and replace any inadequate terminating equipment to meet the modeled post projected emergency loading of 1198 Amps.

Mitigation Option 2: Implement Special Protection Scheme (SPS) to increase the output of the Contra Costa Power Plant (CCPP) by 335 MW. This is the estimated required addition in output by the CCPP with all transmission facilities in service.

12.3.3 B Contingency: 500/230 kV Transformer Bank at Vaca Dixon Sub Overloaded Component: Contra Costa-Delta Switching Yard 230 kV line

Mitigation Option 1: A 4 foot-per-second wind speed re-rate of the Contra Costa-Delta Switching Yard 230 kV line would increase the emergency capacity of the 954 ACSR to 1129 Amps. The additional capacity would be adequate to eliminate the emergency overloads.

Circuit miles is about 18 miles

Mitigation Option 2: Implement Special Protection Scheme (SPS) to increase the output of the CCPP by 335 MW. This is the estimated required addition in output by the CCPP with all transmission facilities in service.

[10] PG&E project T656, 2nd Ravenswood Transformer, reduces this overload from 130% to 105%. The amount of generation reduction needed to mitigate this overload is also reduced from 460 MW to 90 MW.

13. Stand-by Power

This study does not address any requirements for stand-by power that the TGP may require. The Applicant should contact their local PG&E service office regarding the service.

Note: The Applicant is urged to contact their local service office promptly regarding stand-by service in order to ensure its availability for the Project's start-up date.

14. Possible Subsynchronous Resonance Phenomenon at Tesla Area

The purpose of this section is to alert the Applicant that new generating facilities in close proximity to the 500 kV series capacitor sites in the PG&E service area could possibly be subject to sub-synchronous resonance (SSR) phenomenon.

When generators connect at a location that is strongly coupled to a series-compensated transmission system, an interaction between the generator and the system may occur. This interaction is called SSR, and, as the name implies, occurs at frequency under 60 hertz. SSR would occur if, following a system disturbance or switching operation (such as the switching of a generator controller or line switching), a current were induced at a frequency that is the same or nearly the same as one of the complementary frequencies. The complementary frequencies are defined as the difference between 60 hertz and the mechanical frequencies of the turbine, the generator, and the turbine-generator shaft. SSR has the possibility of occurring at steam generators sited at a point in the electrically system where it will "see" (i.e. is electrically close to) the series compensation. SSR, should it occur, could lead to fatigue and possible failure of the turbine-generator shafts. In fact, such failure occurred in the transmission system in the Western United States in the early 1970s before this phenomenon was well understood.

ABB Power T&D Company, Inc. (ABB) has conducted a screening analysis assessing the SSR issue for PG&E as part of a PG&E/ABB evaluation of the PG&E 500 kV series capacitor banks. This analysis indicates that SSR could possibly occur in PG&E service area.

Tesla Substation has one set of 500 kV series capacitors on the Table Mountain-Tesla 500 kV line. It is the Applicant's responsibility to assess the risk of such possible SSR phenomenon for its proposed project. An SSR evaluation will not be part of this SI/FS.

APPENDIX A

SI/FS Study Plan

System Impact/Facilities Study Plan

Midway Power, LLC
Tesla Generation Project

Revision 1

Pacific Gas and Electric Company

May 18, 2001

Table of Contents

Introduction and Project Description

Midway Power, LLC (Applicant), a limited liability company formed by Florida Power and Light Energy (FPLE), had previously requested Pacific Gas and Electric Company's (PG&E's) to conduct a System Impact Study (SIS) for the Tesla Generation Project (TGP). PG&E had conducted the SIS for the TGP, and the final report was issued on February 27, 2001. The SIS was based on operational date of December 31, 2004, and the maximum net output was 844 MW (with three gas combustion turbine generators and one steam turbine generator). The TGP is located approximately one mile northwest of PG&E's Tesla Substation in Alameda County, California. Figure 1 shows the general vicinity of the TGP as well as the transmission facilities in the area.

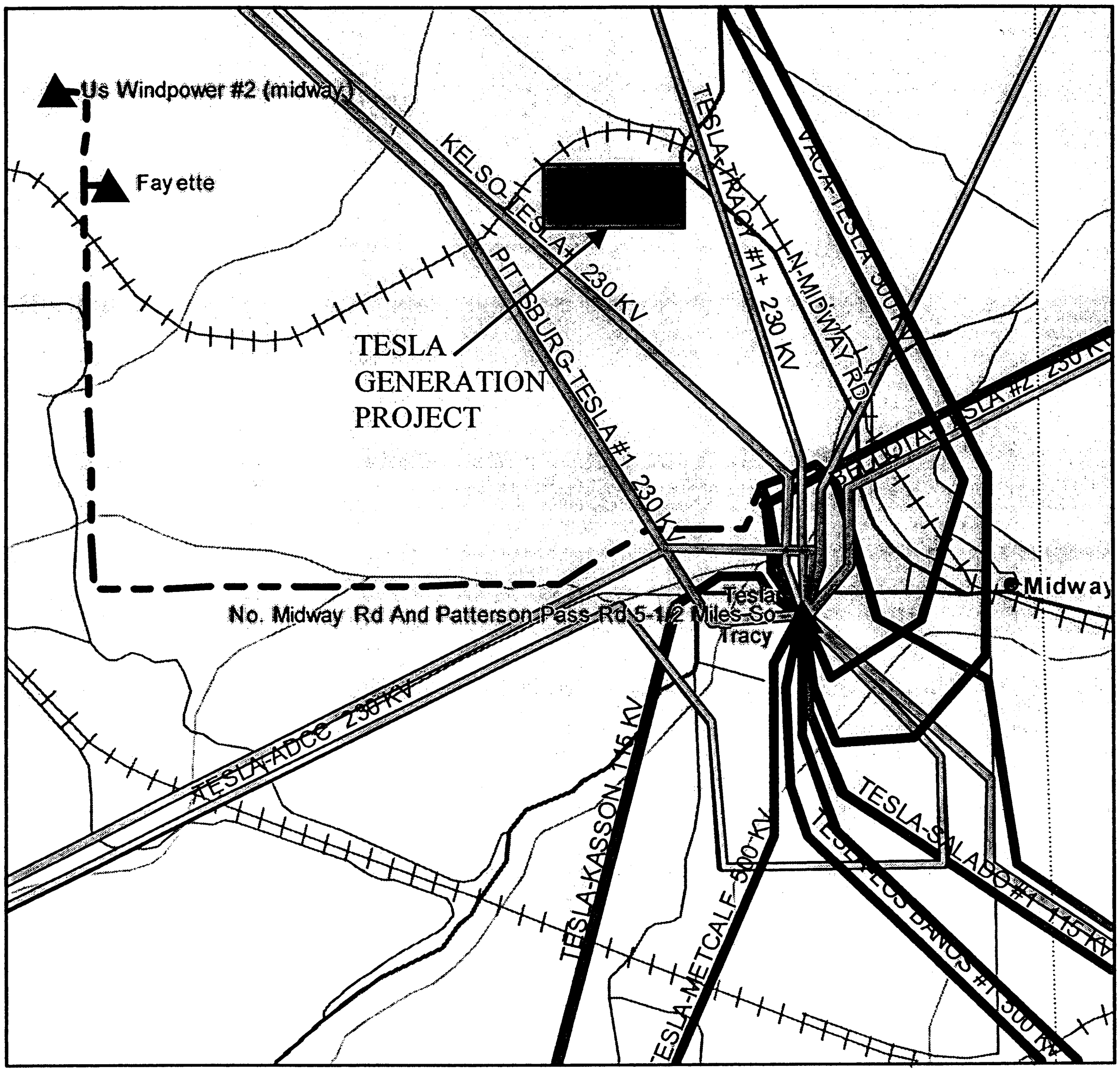

Figure 1: Vicinity Map – Tesla Generation Project

Last March, the Applicant decided to separate the TGP into Tesla I and Tesla II. Tesla I was to consist of four combustion turbine (CT) generators operating in simple cycle mode with a combined net maximum capacity of 692 MW (with 0.85 power factor). Tesla II was to consist of two steam turbine (ST) generators operated in combined cycle mode with the four CTs of Tesla I. The addition of STs would result in an increased output of 464 MW (with 0.85 power factor) from the TGP. Tesla I was planned to be on-line June 1, 2002, and Tesla II was planned to be on-line June 1, 2004. The Applicant also requested PG&E to perform a Facilities Study (FS) for Tesla I and a SIS for Tesla II. Both study plans were issued on March 30, 2001, and studies were begun in April 2001.

Due to the time requirements for permitting process, equipment availability, and other issues, the Applicant has revised the commercial date to February 2004 on the projects previously referred to as Tesla I and Tesla II. The final TGP configuration will consist of two – 2 by 1 combined cycle units with a combined net output of 1156 MW.

Per the Applicant's instruction, PG&E will perform SI/FS together for the TGP. This study plan (revision 1) will combine both Tesla I FS and Tesla II SIS plans into one study plan, and it will determine:

For SIS:

1. The transmission system impact caused solely by the addition of the TGP, and

2. The system reinforcement, if any, necessary to mitigate the impact of the TGP under various system conditions.

For FS:

1. The facilities necessary to mitigate the system impact (as resulted by SIS) and to interconnect the TGP onto the PG&E's transmission grid (including design, construct, and own the new transmission lines).

2. The conductor size of the two new transmission lines based on TGP's output of 1156 MW.

3. The required size of the current limiting reactors at Tesla 230 kV bus (reliability system impact mitigation item).

4. The new land rights, right-the-way, and the route required for the two new transmission lines from the project site to Tesla Substation.

5. The scope of work and the associated cost estimate of the above items.

This Study Plan will form the basis for the SI/FS Agreement by defining the scope, content, assumptions, and terms of reference of the SI/FS.

Study Fee

The Applicant had paid PG&E a one-time study fee of $75,000 for performing the SIS and $60,000 for performing the FS on TGP. No additional study fee is required to conduct this SI/FS.

Schedule

The following schedule shows the milestones associated with the study.

Task	Milestone Description	Target Date
1	Establish study commencement date based on receipt of study fee	4/10/2001
2	Issue revised study plan	5/18/2001
3	Submit completed SI/FS Agreement	5/25/2001
4	Issue power flow analysis results to Cal-ISO and Applicant	7/13/2001
5	Send SI/FS draft report to Applicant and Cal-ISO for review and comments	8/3/2001
6	Receive comments from Applicant and Cal-ISO	8/17/2001
7	Issue final study report	8/31/2001

PG&E must receive a completed SI/FS Agreement from the Applicant by May 25, 2001. If PG&E does not receive the completed Study Agreement by this date, the Interconnection Application will be considered as withdrawn and the Applicant's project position in the generation interconnection queue shall be lost.

Cost Estimates

The following cost estimates will be provided based upon an interconnection commercial operation date in February 2004.

A decision quality cost estimate (developed with a theoretical confidence level of 25%) for PG&E to interconnect the TGP to the PG&E transmission grid will be provided. This estimate will include any substation and transmission line facilities required to interconnect the TGP.

A preliminary cost estimate (developed with a theoretical confidence level of 50%) of transmission reliability upgrades needed to mitigate any system impacts to PG&E's existing facilities that are caused solely by the interconnection of the TGP will be provided.

This cost estimate will not include any facilities constructed, owned, and operated by the Applicant.

All costs provided will be estimates only. Charges will be made based upon the actual costs incurred.

Interconnection Plan

TGP will be connected to the PG&E's 230 kV Bus 'E' at the Tesla Substation via two 230 kV transmission lines from the Applicant's site. The TGP will be configured as shown in Figure 2.

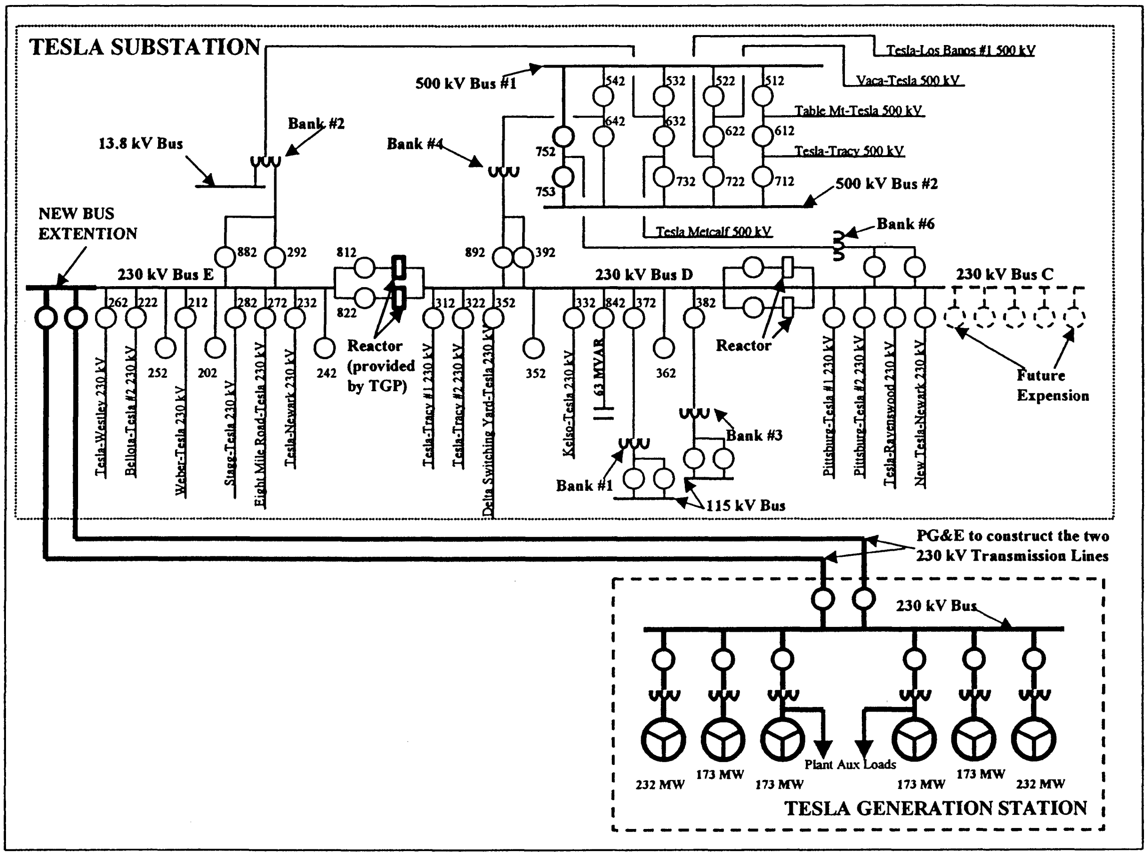

Figure 2: Configuration Diagram – Tesla Generation Project

Study Assumptions

PG&E will conduct the SI/FS under the following assumptions:

1) The maximum output delivery from the TGP to the PG&E transmission grid will be 1156 MW modeled at 0.85 lagging power factor, and it will be on-line at this capacity by February 2004.

2) This study will take into account the planned generating facilities in Northern California whose schedules are concurrent with the operation schedule of TGP. These facilities are described in the section discussing the power flow base cases.

3) The study will take into account all the approved PG&E reliability projects that will be operational by February 2004.

1) The new transmission line conductor size will be selected based on the maximum output of 1156 MW at 0.85 lagging power factor. Two 230 kV transmission lines are required. PG&E will design and construct these lines.

2) System Protection Analysis will be conducted based on Tesla output of 1156 MW.

3) The new current limiting reactors at Tesla 230 kV will be sized based on the maximum output of 1156 MW at 0.85 lagging power factor.

4) Applicant's data submitted with the application will be used for this study.

Note: These assumptions and any changes thereto must be confirmed before the SI/FS can commence.

Power Flow Base Case Assumptions

The power flow base cases will be used in this study:

1) 2004 Summer Peak Full Loop Area Base Case:

   Power flow analysis will be performed using PG&E's 2004 Summer Peak Full Loop Base Case (in General Electric Power Flow format). This base case was developed from PG&E's 2001 base case series. This base case has a 1-in-10 year heat wave load forecast for the Sacramento, Sierra, Stockton, and Stanislaus areas. This base case will be used to evaluate the impact of the TGP on PG&E's 60-500 kV system.

2) 2004 Spring Full Loop Base Case:

   Power flow analysis will also be performed using the 2004 Spring Full Loop Base Case in order to evaluate the potential congestion on transmission facilities with lower load and high generation level during a typical Spring season. Typical Spring season load (50-65% of summer peak) will be applied in this Spring Base Case. Hydro generation will be modeled in a very high level as typical in the spring season. This base case will be used to evaluate the impact of the TGP on PG&E's 60-500 kV system.

These base cases will include all the approved PG&E reliability projects that will be operational by summer 2004. The following major reliability projects will be included:

- Install a third 500/230 kV transformer at Tesla Substation
- Install a second 500/230 kV transformer at Tracy Substation
- Install a third 500/230 kV transformer at Metcalf Substation
- A new Tesla-Newark 230 kV line
- Newark-San Mateo 230 kV line loop into Ravenswood Substation

ξ Static Capacitors (350 MW) at Metcalf 500 kV

ξ Static Capacitors (100 MW) at Martin 115 kV

ξ Newark Substation Bank #7, 9, and 11 TCAP

The base case will also include the following major proposed generating facilities in Northern California:

1) Calpine/Bechtel - 880 MW Delta Energy Center (DEC), interconnecting with the 230 kV bus at the Pittsburg Power Plant switchyard.

2) Calpine/Bechtel - 600 MW Metcalf Energy Center (MEC), interconnecting with the Metcalf - Monta Vista #4 230 kV line, through the MEC switchyard.

3) PG&E NEG - La Paloma generation facility interconnecting at Midway 230 kV bus section D; La Paloma generation facility will be will be modeled at 1110 MW in summer and 1160 MW in spring and winter.

4) Calpine - 500 MW Los Medanos Energy Center (LMEC), interconnecting with the 115 kV bus at the Pittsburg Power Plant switchyard.

5) Texaco - 338 MW Sunrise Generation Facility interconnecting at La Paloma Switching Station.

6) Three Mountain Power Company - 530 MW project interconnecting to PG&E's Pit 1 – Pit 3 and Pit 1 – Cottonwood 230 kV lines.

7) GWF - 130 MW Hanford, interconnecting to Kingxburg - Henrietta 115 kV line in Fresno area.

8) Duke Energy North America Corporation (DENA) - 1080 MW Moss Landing project (MLPP), interconnecting with the existing 230 kV bus at the Moss Landing Power Plant.

9) Mirant - 530 MW Contra Costa Power Plant Capacity Increase Project, interconnecting to Contra Costa PP 230 kV bus.

10) The Midway-Sunset generation facility will be 490 MW in summer, 540 MW in spring, and 540 MW winter. Midway-Sunset generation facility will be interconnected at Midway 230 kV bus section E.

11) Sempra - 500 MW Elk Hills Power Project, interconnecting at Midway 230 kV bus.

12) FPLE - 150 MW High Wind, tapping off the Vaca -Contra Costa #2 230 kV line.

13) United Golden Gate PP - 595 MW generating facilities, interconnecting with the San Mateo - Martin #5 and #6 115 kV lines.

14) Wellhead Electric - 22 MW Stockton Cogen Project, interconnecting with Newark Sierra Paper Board 60 kV Tap on the Stockton "A" #1 60 kV line.

15) Morro Bay Modernization Project replacing the existing Morro Bay Power Plant with 1,200 MW of generation.

16) Panda - 150 MW West 1-3, interconnecting with Vaca Dixon - Contra Costa #1 230 kV line.

17) Calpine Corporation - 500 MW Sutter Facility, interconnecting with WAPA's Elverta - Olinda and Elverta - Keswick 230 kV.

18) FPLE - 560 MW Elverta Project, interconnecting with WAPA system.

19) Calpine – 1,070 MW East Altamont Generating Project interconnecting at loop the Tracy - Westley 230 kV circuit near Tracy Substation.

Study Scope

The SI/FS will study the impact of added generation by the TGP on PG&E's transmission system. The specific studies conducted for the SI/FS are outlined in this section.

Steady State Power Flow Analysis

The two base cases will be used to simulate the impact of the new facility during normal operating conditions, as well as, single and selected multiple (ISO Categories "B" and "C") outages. The study will cover the transmission facilities within PG&E's Stockton, Stanislaus, Sacramento, East Bay, Mission, Diablo, San Jose, and De Anza planning areas.

The single (ISO Category "B") and selected multiple (ISO Category "C") contingencies include the following outages[1]:

ISO Category "B"

- All single generator outages within the study area.
- All single (60-230 kV) transmission circuit outages within the study area.
- All 500 kV single transmission circuit outages from Malin to Los Banos.
- All single transformer outages within the study area.
- Overlapping single generator and transmission circuit outages for the transmission lines and generators within the study area.

[1] As soon as the "B" and "C" outage list is put together, PG&E will send it to Cal-ISO for review and comment prior to running the outage evaluation.

ISO Category "C"

- Selected bus outages (115, 230 and 500 kV) within the study area.
- Outages caused by breaker failures (excluding bus tie and sectionalizing breakers) at the same bus section above.
- Combination of any two-generator/transmission line/transformer outages (except ones included above in Category "B") within the study area.
- Outages of double circuit tower lines (115, 230, 500 kV) within the study area.

Dynamic Stability Analysis

Dynamic stability studies will be conducted using the 2005 Summer Peak Full Loop Base Case to ensure that the transmission system remains in operating equilibrium through abnormal operating conditions after the new facility begins operation. This full loop base case was developed from PG&E's 2000 base case series. Other PG&E approved transmission projects and new generation projects that will be operational by Summer 2005 will also be modeled in this 2005 case.

Disturbance simulations will be performed for a study period of 20 seconds to determine whether the new facility will create any system instability during the following line and generator outages:

NERC/CAISO Category "B" Contingencies:

a) Full load rejection of the TGP power plant.

b) A three-phase fault with a normal 6-cycle clearing time at the TGP 230 kV bus, followed by loss of one of the Tesla-TGP 230 kV lines.

c) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus, followed by loss of the Tesla-Ravenswood 230 kV line.

d) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus, followed by loss of the Tesla-Newark 230 kV line.

e) A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus, followed by loss of the Tesla-Tracy #1 230 kV line.

f) A three-phase fault with a normal 6-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla 500/230 kV Bank #2.

g) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Table Mountain-Tesla 500 kV line.

h) A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Vaca-Tesla 500 kV line.

- **i)** A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Tracy 500 kV line.
- **j)** A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Los Banos 500 kV line.
- **k)** A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by loss of the Tesla-Metcalf 500 kV line.
- **l)** A three-phase fault with a normal 6-cycle clearing time at the Tesla 115 kV bus, followed by loss of the Tesla 230/115 kV Bank #3.

NERC/CAISO Category "C" Contingencies:

- **m)** A three-phase fault with a normal 6-cycle clearing time on the TGP 230 kV bus.
- **n)** A three-phase fault with a normal 6-cycle clearing time on the Tesla 230 kV Bus, Section D.
- **o)** A three-phase fault with a normal 6-cycle clearing time on the Tesla 230 kV Bus, Section E.
- **p)** A three-phase fault with a normal 6-cycle clearing time on the Tesla 230 kV Bus, Section C.
- **q)** A three-phase fault with a normal 6-cycle clearing time on the Tesla 115 Bus #1 or #2.
- **r)** A three-phase fault with a normal 6-cycle clearing time at the TGP 230 kV bus followed by a simultaneous loss of both Tesla-TGP 230 kV lines.
- **s)** A three-phase fault with a normal 6-cycle clearing time at the Tesla 230 kV bus followed by a simultaneous loss of both Tesla-Tracy 230 kV lines.
- **t)** A three-phase fault with a normal 6-cycle clearing time at the TGP 230 kV bus followed by a simultaneous loss of both Tesla-Ravenswood and Tesla-Newark 230 kV lines.
- **u)** A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus followed by a simultaneous loss of the Table Mountain-Tesla and Vaca-Tesla 500 kV lines.
- **v)** A three-phase fault with a normal 4-cycle clearing time at the Tesla 500 kV bus, followed by a simultaneous loss of the Tesla-Tracy and Tesla-Los Banos 500 kV lines.
- **w)** A single-line-to-ground fault at one of the line breakers at the Tesla 230 kV bus Section C, with a breaker failure condition.
- **x)** A single-line-to-ground fault at one of the line breakers at the Tesla 230 kV bus Section D, with a breaker failure condition.

Post Transient Analysis

Post transient study will be performed when any outage causes greater than 5% voltage drop on the bus during the power flow analysis.

System Protection Analysis

Short circuit studies will be performed to determine the impact of increased fault duty resulting from the added generation. The study will determine the maximum fault currents in the vicinity of the proposed project and it will identify equipment that would become overstressed as a result of the added generation. New protection requirements together with protection modification at the nearby transmission substations, if needed, would also be identified.

Short circuit study will determine the maximum fault currents before and after the TGP at the following buses:

- Tesla 230 kV Bus C
- Tesla 230 kV Bus D
- Tesla 230 kV Bus E
- Tesla 500 kV Bus
- Tesla 115 kV Bus
- TGP 230 kV Bus

There will be 4 combustion turbine (CT) generators and 2 steam turbine (ST) generators. The CT and ST generator and step up transformer data are provided by the Applicant and listed below:

<u>CT Generators</u>

- Synchronous reactance (Xd) = 2.024 pu @ 221.4 MVA
- Transient reactance (X'd) = 0.305 pu @ 221.4 MVA
- Sub-transient reactance (X"d) = 0.225 pu @ 221.4 MVA
- Negative Sequence reactance (X.) = 0.150 pu @ 221.4 MVA
- Zero Sequence reactance (Xo) = 0.007 pu @ 221.4 MVA

<u>ST Generators</u>

Nameplate Rating: 285 MVA, 0.85 (lag) power factor, 3600 RPM, and 18 kV output voltage.

* Synchronous reactance (Xd) = 1.91 pu @ 285 MVA
* Transient reactance (X'd) = 0.308 pu @ 285 MVA
* Sub-transient reactance (X"d) = 0.249 pu @ 285 MVA
* Zero Sequence reactance (Xo) = 0.13 pu @ 285 MVA

Step-up Transformers

For CT's: 18/235 kV, Z = 0.3 + j12% @ 215 MVA

For SG's: 18/235 kV, Z = 0.3 + j12% @ 300 MVA

In addition, the short circuit study will be conducted to determine the required size of the current limiting reactors at the Tesla 230 kV buses. The reactors will be sized based on the 1156 MW build-out.

Substation Evaluation

The substation evaluation will determine new equipment, needed to accommodate the new generation. It will also identify existing equipment requiring upgrades in order to mitigate overloading or overstressing due to the new generation. New protection requirements, together with protection modifications at the nearby transmission substations, if needed, would also be identified. A cost estimate of the substation work scope will be provided.

Transmission Line Evaluation

PG&E will determine the required conductor size, work scope, and cost of the two 230 kV transmission lines. PG&E will design and construct these transmission lines.

Land Evaluation

PG&E's land department will perform an evaluation to determine the scope and cost of the land rights required by the interconnection of TGP. PG&E will determine the route for the two 230 kV double circuit lines. PG&E will obtain the right-of-way easement for the transmission line corridor.

Environmental Permitting

The Applicant will be responsible for including all work required by PG&E for directly interconnecting the project to PG&E's transmission grid in the environmental review for the Applicant's application for a discretionary permit to build the project. If the lead agency finds that the work will not have any significant unavoidable environment impacts, PG&E will not apply for any permits from the California Public Utility Commission (CPUC) for this interconnection work unless ordered to do so by the CPUC. Rather, PG&E will follow the notice requirement set out in Section III and XI.B of the CPUC's General Order (GO) 131-D, including mailing to agencies, posting, publication and submittal of an informational advice letter to the CPUC. If the lead agency finds that this work will have any significant unavoidable environmental impact, or if the Project does not require another discretionary permit, then PG&E will comply with applicable GO 131-D permitting requirements.

Items Excluded from Study Scope

Stand-by Power

This study does not address any requirements for stand-by power that the TGP may require. The Applicant should contact their local PG&E service office regarding the service.

Note: The developer is urged to contact their local service office promptly regarding stand-by service in order to ensure its availability for the Project's start-up date.

Possible Subsynchronous Resonance Phenomenon at Tesla Area

The purpose of this section is to alert the Applicant that new generating facilities in close proximity to the 500 kV series capacitor sites in the PG&E service area could possibly be subject to sub-synchronous resonance (SSR) phenomenon.

When generators connect at a location that is strongly coupled to a series-compensated transmission system, an interaction between the generator and the system may occur. This interaction is called SSR, and, as the name implies, occurs at frequency under 60 hertz. SSR would occur if, following a system disturbance or switching operation (such as the switching of a generator controller or line switching), a current were induced at a frequency that is the same or nearly the same as one of the complementary frequencies. The complementary frequencies are defined as the difference between 60 hertz and the mechanical frequencies of the turbine, the generator, and the turbine-generator shaft. SSR has the possibility of occurring at steam generators sited at a point in the electrically system where it will "see" (i.e. is electrically close to) the series compensation. SSR, should it occur, could lead to fatigue and possible failure of the turbine-generator shafts. In fact, such failure occurred in the transmission system in the Western United States in the early 1970s before this phenomenon was well understood.

ABB Power T&D Company, Inc. (ABB) has conducted a screening analysis assessing the SSR issue for PG&E as part of a PG&E/ABB evaluation of the PG&E 500 kV series capacitor banks. This analysis indicates that SSR could possibly occur in PG&E service area.

Tesla Substation has one set of 500 kV series capacitors on the Table Mountain-Tesla 500 kV line. It is the developer's responsibility to assess the risk of such possible SSR phenomenon for its proposed project. An SSR evaluation will not be part of this SI/FS.

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System Impact/Facilities Study Agreement

_________________________ (Applicant) has reviewed the study plan for the interconnection of Applicant's electric generating plant with PG&E's system at ______________________________, _____________State of California and agrees with the proposed study plan.

Applicant agrees to pay the proposed study fee.

Dated this ______ day of ____________, 2001

APPLICANT:

BY: ____________________________________
(Signature)

____
(Type or Print Name)

TITLE: ____________________________________

MAILING ADDRESS:

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